

REPORT DOCUMENTATION PAGE

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20 May 1999

SUBJECT: Authorization for Release of Technical Information, Control Number: AFRL-PR-ED-TP-FY99-0106
Jay Levine, "Plume Phenomenology Program"

International presentation

~~(Foreign Release)~~ Dist A

PLUME PHENOMENOLOGY PROGRAM



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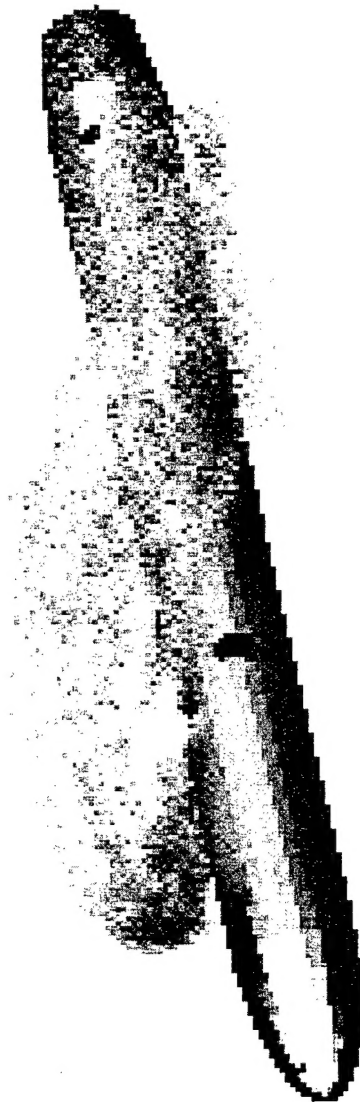
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4 June 1999



Plume-Vehicle Interactions

Jet Interaction Effects -
Body Heating, Aerodynamic Forces

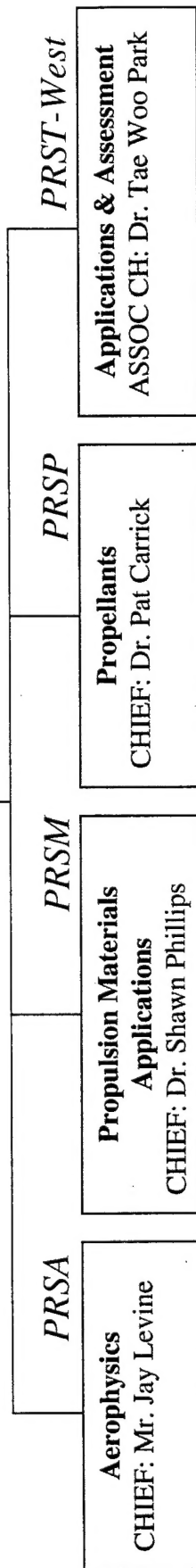




AFRL Propulsion Directorate

Propulsion Sciences and Advanced Concepts Division

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- Rocket plume phenomenology
- Combustion processes and devices
- Spray combustion
- Energetic-material decomposition
- Plasma discharges
- Computational fluid dynamics
- Supercritical fluid mechanics
- Rarefied gas dynamics
- Non-equilibrium flows

- Advanced polymeric components
- Hybrid polymers
- Advanced component fabrication techniques
- Carbon-carbon components
- High temperature coatings
- Nanocrystalline materials
- Functionally graded components
- Solid-propellant fracture mechanics
- Microtube technology
- Ceramic processing

- High energy-density matter
- Liquid rocket propellants and additives
- Solid and hybrid rocket motors and propellants
- Cryogenic propellants
- Energetic molecule synthesis and characterization
- Computational chemistry
- Analytic chemistry
- Environmental propulsion technology
- Propellant hazard analysis
- Missile safety
- Advanced propulsion concepts

- System-level performance analysis of aerospace vehicles
- Flight trajectory simulations
- Liquid rocket power balance analysis
- Vehicle flight performance prediction
- Propellant requirement estimation
- Technical risk assessment
- Reliability analysis
- Program cost estimation



...What We Do

- Primary U.S. Activity for Plume Related Signature Modeling and Analysis
- Develop and Validate Plume Codes for Distribution to DoD Community
 - Propulsion Performance
 - Exhaust Plume Characteristics and Signatures
- Both In-House and Contracted Work
 - Substantial In-House Computing and Scientific Visualization Capabilities



Background

Types of Plume Signatures

- **Propulsion Systems Produce the Following Signatures**
 - Exhaust Plumes
 - Plume/Body Interactions
- **These Signatures can Impact the Effectiveness of a Missile Defense System During Boost, Ascent, and Descent Phases**



Background

Plumes Impact Many Missile Defense Functions

- **Passive Signatures: Emissions in the UV-LWIR (0.1-25 μm)**
 - Detection, Acquisition, Tracking, Typing, Cueing, Handover, Aim-point Selection, Band Pass Selection, Sensor Ranging
- **Active Signatures: Laser and Radar Attenuation and Backscatter**
 - All Weather Detection and Tracking, Typing, Communications, Aim-point Selection, and Sensor Ranging
- **Vehicle/Plume Interactions**
 - Base Heating, Engine Heat Sink, Pressure Distribution, Flow Separation, Shocks, and Contamination

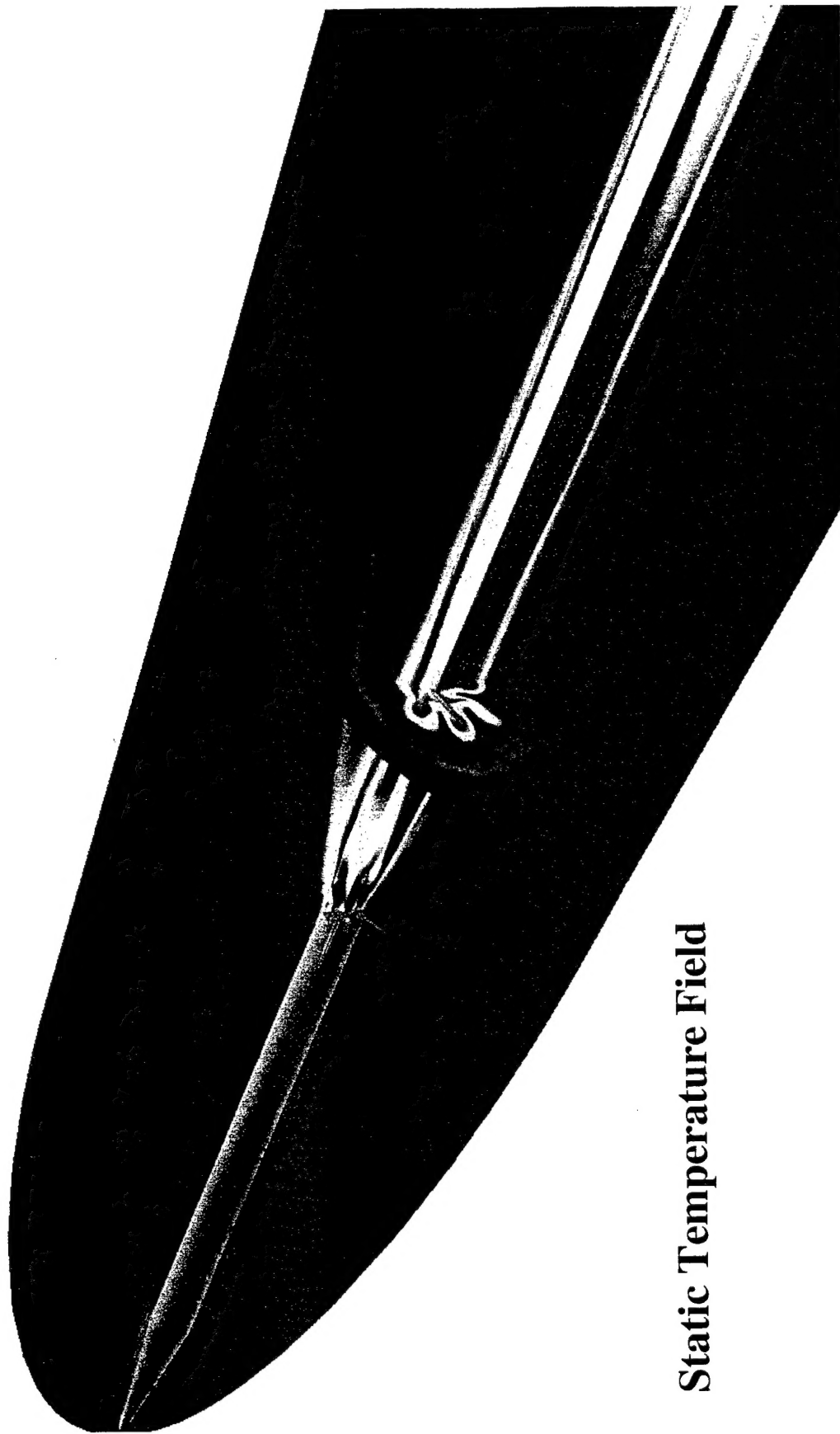


Plume Phenomenology Implications: A Few Examples

- **Plume Asymmetries**
 - 3-D Effects (Fins, Gas Generators, TVC Vanes, etc)
 - Angle-of-Attack
- **Afterburning Cessation and Shutdown**
- **Contamination**



3-D Simulations of Plume Flows



Static Temperature Field



3-D Radiation Predictions

